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I, LEANNE MYNOTT, MANAGER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2004905021 for a patent by AUSTRALIAN MUD COMPANY LTD as filed on 03 September 2004.

WITNESS my hand this
Fourteenth day of September 2005

LEANNE MYNOTT
MANAGER EXAMINATION SUPPORT
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P/00/009 28/5/91
Regulation 3.2

ORIGINAL

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: "Core Sample Orientation"

The invention is described in the following statement:

"Core Sample Orientation"

Field of the Invention

This invention relates to identification of core sample orientation. More particularly, the invention relates to an orientation device for providing an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, and also to a method of identification of core sample orientation.

Background Art

There is a need for core sampling in geological surveying operations.

Core samples are obtained through a core drilling operation. Core drilling is typically conducted with a core drill comprising outer and inner tube assemblies. A cutting head is attached to the outer tube assembly, so that rotational torque applied to the outer tube assembly is transmitted to the cutting head. A core is generated during the drilling operation, the core progressively extending along the inner tube assembly as drilling progresses. When a core sample is required, the core within the inner tube assembly is fractured. The inner tube assembly and the fractured core sample contained therein, are then retrieved from within the drill hole, typically by way of a retrieval cable lowered down the drill hole. Once the inner tube assembly has been brought to ground surface, the core sample can be removed and subjected to the necessary analysis.

Typically, the core drilling operation is performed at an angle to the vertical, and it is desirable for analysis purposes to have an indication of the orientation of the core sample relative to the ground from which it was extracted. It is therefore important that there be some means of identifying the orientation the core sample had within the ground prior to it having been brought to the surface.

Core orientation devices are used to provide an indication of the orientation of the core sample.

One common way of obtaining an indication of the orientation of a core sample is through use of an orientation spear comprising a marker (such as a crayon) projecting from one end of a thin steel shank, the other end of which is attached to a wire line.

The orientation spear is lowered down the drill hole, prior to the inner tube assembly being introduced. The marker on the orientation spear strikes the facing surface of material from which the core is to be generated, leaving a mark thereon. Because of gravity, the mark is on the lower side of the drill hole. The inner tube assembly is then introduced into the outer tube assembly in the drill hole. As drilling proceeds, a core sample is generated within the inner tube assembly. The core sample so generated carries the mark which was previously applied. Upon completion of the core drilling run and retrieval of the core sample, the mark provides an indication of the orientation of the core sample at the time it was in the ground.

There are also mechanical core orientation devices for marking a core sample prior to its extraction from the drill hole. Typically, mechanical devices are adapted to be incorporated in the inner tube assembly for marking the core. An example of such a mechanical orientation device is disclosed in WO 03/038232.

The present invention seeks to provide a core orientation device which does not require a physical mark to be applied to the facing surface of material from which a core is to be generated.

Disclosure of the Invention

According to a first aspect of the invention there is provided an orientation device for providing an indication of the orientation of a core sample relative to a body of material from which the core has been extracted, the orientation device comprising means for determining and storing the orientation of the device at predetermined time intervals relative to a reference time, means for inputting a selected time interval, means for relating the selected time interval to one of the

predetermined time intervals and providing an indication of the orientation of the device at the selected time interval.

Such an orientation device is typically attached to an inner tube assembly of a core drill and is fixed against rotation relative thereto. For this purpose, the orientation device according to the invention preferably includes means for attachment to the inner tube assembly.

Preferably, the orientation device further includes means for comparing the orientation of the device at the selected time interval to the orientation of the device that any subsequent time and providing an indication of the direction in which the device should be rotated in order to bring it into an orientation corresponding to the orientation of the device at the selected time.

According to a second aspect of the invention there is provided an orientation device for providing an indication of the orientation of a core sample relative to a body of material from which the core sample has been extracted, the orientation device comprising means for generating signals responsive to the orientation of the device, a processor for receiving the generated signals and for processing the signals to generate orientation data representative of the orientation of the device, means for storing the orientation data at prescribed time intervals, means for inputting a signal representative of a selected time interval to the processor, the processor operating to relate the selected time interval to the predetermined time intervals and output a signal indicative of the orientation of the device at the selected time interval.

Preferably, further data is generated representative of the orientation of the device at any subsequent time and the processor is operable to output a signal to a display means to provide a visual indication of the direction in which the device should be rotated at said subsequent time in order to bring the device into an orientation corresponding to its orientation at the selected time.

According to a third aspect of the invention there is provided a core drill comprising an inner tube assembly and an orientation device according to the first aspect of the invention.

According to a fourth aspect of the invention there is provided a core drill comprising an inner tube assembly and an orientation device according to the second aspect of the invention.

According to a fifth aspect of the invention there is provided a method of providing an indication of the orientation of a core sample relative to a body of material from which the core sample has been extracted, the method comprising: drilling a core sample from a body of material with a core drill having an inner tube assembly; recording the orientation of the inner tube at predetermined time intervals with reference to an initial reference time during said drilling; recording the specific time interval beyond the reference time at which the core sample was separated from the body of material; removing the inner tube assembly and core sample contained therein from the body of material; and relating the recorded specific time to the recorded time intervals to obtain an indication of the orientation of the inner tube and consequently the core contained therein at the specific time interval.

Preferably, the method according to the invention is performed using an orientation device attached to the inner tube assembly, the orientation device being in accordance with either the first or second aspect of the invention.

Brief Description of the Drawings

The invention will be better understood by reference to the following description of one specific embodiment thereof as shown in the accompanying drawings in which:

Figure 1 is a schematic view of a core drill incorporating an orientation device according to the embodiment;

Figure 2 is a schematic side elevational view of the orientation device according to the embodiment;

Figure 3 is a further schematic side elevational view of the orientation device;

Figure 4 is a schematic view of a keypad and display provided at one end of the orientation device;

Figure 5 is a view similar to Figure 4, except that shading is incorporated to identify different colours on the end panel; and

Figure 6 is a block diagram illustrating various components of the orientation device.

Best Mode(s) for Carrying Out the Invention

The embodiment shown in the drawings is directed to an orientation device 10 for use with a core drill 11 to provide an indication of the orientation of a core sample obtained in a core drilling operation performed by the core drill 11.

The core drill 11 comprises an outer tube assembly 13 and an inner tube assembly 15 of generally conventional construction. The orientation device 10 according to the embodiment is incorporated in the inner tube assembly 15, as shown in Figure 1 of the drawings. The inner tube assembly comprises upper and lower parts 15a, 15b between which the orientation device 10 is fitted. The upper part 15a includes a bearing 16, with the portion above the bearing 16 being rotatable with the outer tube assembly 13 and the portion below the bearing 16 being restrained against rotation because of frictional engagement with the core being generated.

Incorporating the orientation device 10 in the inner tube assembly 15 increases the overall length of the inner tube assembly, a consequence of which is that the overall length of the outer tube assembly 13 needs to be also increased. A

spacer 17 is provided in the outer tube assembly 13 for this purpose. Apart from modifications to the inner tube assembly 15 to accommodate the orientation tool 10, and also the spacer 17 provided in the outer tube assembly 13, the core drill 11 is of conventional construction and operates in a conventional way.

The orientation device 10 comprises a housing 21 of generally cylindrical construction defining a central longitudinal axis. The housing 21 has a generally cylindrical side wall 23 and two opposed ends 25, 27. End 25 is open and internally threaded to provide a female threaded formation (not shown). A complementary male threaded formation 29 is provided on the cylindrical side 23 of the housing 21 inwardly spaced from the other end 27.

The female threaded formation (not shown) and the male threaded formation 29 are provided so that the orientation device 10 can be installed between, and in threaded engagement with, the upper and lower parts 15a, 15b of the inner tube assembly 15, as shown in Figure 1.

A membrane keypad 31 and an LCD display 33 are provided at end 27 of the orientation device 10. With this arrangement, the keypad 31 is accessible for operation from the end 27 and the display 33 is also visible from that end, but of course only when the orientation device 10 is not connected to upper part 15a of the inner tube assembly 15. The keypad 31 incorporates a window section 35 through which the LCD display 33 is visible, as shown in Figures 4 and 5. The keypad 31 has four keys in this embodiment, identified in Figure 4 as "N", "R", "+" and "-" keys.

The housing 21 accommodates an internal chassis 37.

The chassis 37 has a cavity 39 which accommodates shock absorbing material 41 encasing a triaxial accelerometer means 43.

The shock absorbing material 41 comprises several layers of cushioning. Specifically, there is an outer cushioning layer, an intermediate cushioning layer, and an inner cushioning layer which embraces the triaxial accelerometer means,

with the robustness of cushioning progressively decreasing from the outer layer to the inner layer.

The chassis 37 also accommodates a main printed circuit board 47 and an electrical power source 49 in the form of a lithium battery pack.

The main printed circuit board 47 incorporates an analogue-to-digital converter 51, a low-power microcontroller 53 which provides a processor, a timer 55 and non-volatile memory 57, as illustrated schematically in Figure 6.

The triaxial accelerometer means 43 comprises three internal silicon accelerometers pointing in orthogonal directions X, Y and Z. The three accelerometers measure components of the earth's gravitational field.

Mathematically transforming the outputs from the three accelerometers allows the orientation of the device 10 about its longitudinal axis to be determined. More particularly, signals produced by the triaxial accelerometer means 43 indicative of the orientation of the device 10 are transmitted to the analogue-to-digital converter 51 which in turn transmits a signal to the microcontroller 53. When the orientation device 10 is operating, the orientation of the device is determined at regular intervals as determined by the timer 55 and the orientation reading stored in memory 57. In this embodiment, the time intervals at which the orientation is determined and stored comprises intervals of one minute. In this way, there is a stored record of the orientation of the device 10 at minute intervals. The orientation of the orientation device 10 of course corresponds to the orientation of the lower part 15b of the inner tube assembly 15 which in turn corresponds to the orientation of a core sample progressively entering the inner tube assembly 15, as the lower part 15b does not rotate relative to the core sample.

The time intervals of one minute at which data indicative of the orientation of the device 10 is stored in memory 57 commences from a reference time which corresponds to the time at which the orientation device was started through an operation performed through the keypad 31. In this embodiment, the orientation

device is started by pressing the "N" key on the keypad. It is also necessary to record the time duration subsequent to starting of the orientation device, the purpose of which will be explained later. This time duration is typically recorded by way of a timer such as a stop watch. Typically, the stop watch is started at the time that the orientation device 10 displays a signal on the display 31 indicating that operation of the orientation device has started.

Once the orientation device 10 has been started and recording of the subsequent time duration commenced, the inner tube assembly 15 is inserted into the drill hole for reception in the outer tube assembly 13, and the core drilling operation then commenced. During the drilling operation, a core is progressively generated within the inner tube assembly, as previous explained. When the core is to be extracted, the core drill operator refers to the timer and notes the time duration involved. Specifically, the operator either notes the full minute that has previously elapsed or waits until the next full minute elapses, and then records that time (as it must be recalled later). The operator then initiates the procedure for breaking the core from the body of material, ensuring that no rotation of the inner tube assembly 15 occurs. The inner tube assembly 15 is retrieved from the drill hole in the conventional manner.

At the surface, the upper part 15a of the inner tube assembly 15 is unscrewed from the orientation device 10, so as to the expose the end 27 thereof to provide access to the keypad 31 and display 33. The time duration as measured by the timer is then inputted into the orientation device through the keypad 31. In this embodiment, this is done by pressing the "R" key to display numbers "00", and then pressing the +/- keys to display the relevant time duration in minutes. Once the time has been entered, the key "R" is pressed once and the display then provides a graphical indication of the direction in which the orientation device 10 and the lower part 15b of the inner tube assembly 15 attached thereto should be rotated in order to bring the core contained within the inner tube assembly 15 into an orientation corresponding to its orientation at the time that it was in the ground. Once the required orientation has been established, the core sample within the inner tube assembly 15 can be marked as necessary. After removal of

the core sample from the lower part 15b of the inner tube assembly 15, the upper part 15a can be fitted onto the orientation device 10 and the inner tube assembly 15 used for the next core sample drilling stage.

The process by which the orientation device 10 determines and provides a graphical indication of the direction in which it should be rotated, together with the lower part 15b of the inner tube assembly 15 attached thereto, in order to be at an orientation corresponding to the orientation of the core sample in its original position within the ground, will now be described.

The time measurement measured by the timer and entered into the keypad 31 represents the duration of time between starting the orientation device 10 and the point at which the particular drilling process was terminated in order to fracture the core sample from the body of material to which it is attached so that the core sample could be retrieved from the drill hole and brought to surface level.

As previously explained, the orientation of the orientation device 10 is determined at predetermined intervals, which are minute intervals in this embodiment. The timer simply allows identification of the particular minute interval at which the appropriate orientation reading was taken and recorded. Inputting the time measurement into the keypad 31 allows the controller 53 to compare the inputted reading to the various stored readings and identify the relevant orientation reading. The triaxial accelerometer means 41 provides signals responsive to the orientation of the orientation device 10 at any instant in time, including when operating at surface level. Such signals allow the controller 53 to process the signals and determine the orientation of the device at any instant. The controller 53 can compare the instant of the device at surface level at any instant in time to the particular recorded reading corresponding to the orientation of the device at the time that the core sample was separated from the body of material to which it was previously attached. This comparison is processed to provide data which is outputted to the display 33 to provide a visual

indication of the direction in which the orientation device should be rotated, as previously explained.

Typically, the visual indication comprises a directional arrow arrangement showing the required rotational direction. Once the orientation device 10 is at the required orientation, the display 33 provides an image representing that condition.

From the forgoing, it is evident that the present invention provides an orientation device which does not require physical marking of a core sample prior to extraction thereof from the ground. Indeed, the orientation device according to the embodiment is particularly convenient for an operator to use. All that is required is for the operator to start the orientation device prior to the inner tube assembly 15 being inserted into the drill hole, and contemporaneously start a timer for recording the time duration before the drilling operation ceases to allow the generated core sample to be retrieved.

Modifications and improvements may be made without departing from the scope of the invention.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Dated this Third day of September 2004.

Australian Mud Company Ltd
Applicant

Wray & Associates
Perth, Western Australia
Patent Attorneys for the Applicant

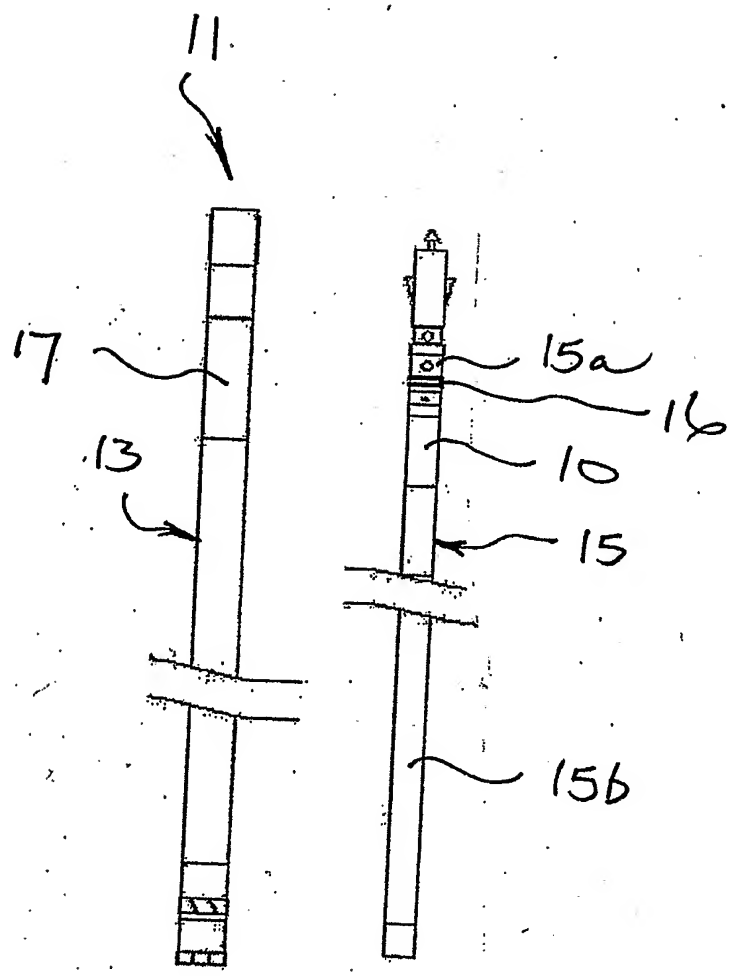

FIG. 1

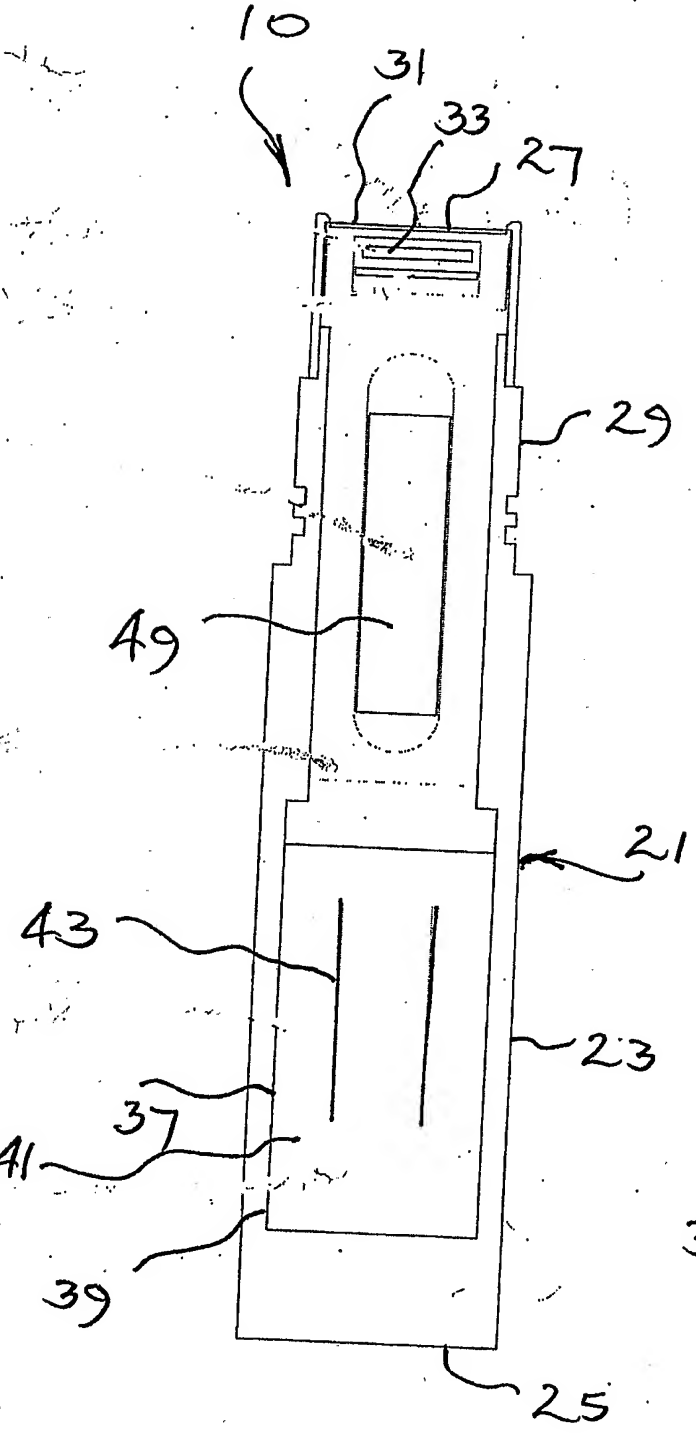
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FIG. 2

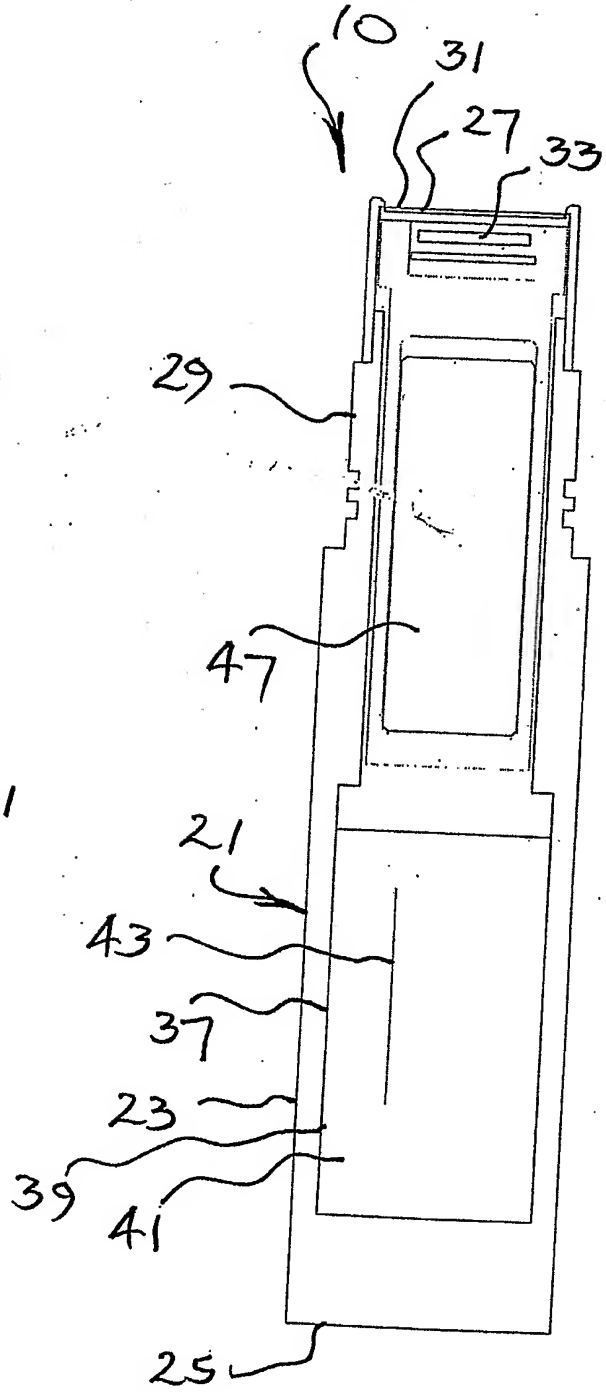
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FIG. 3

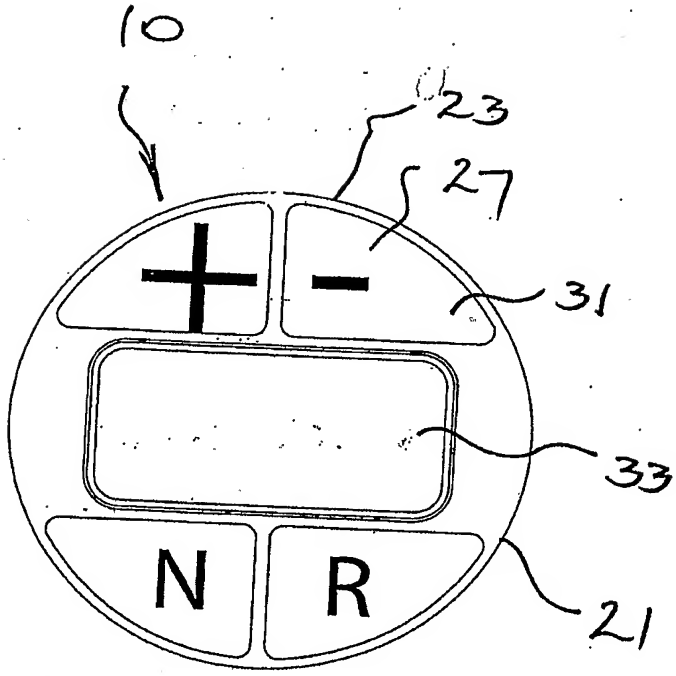


FIG. 4

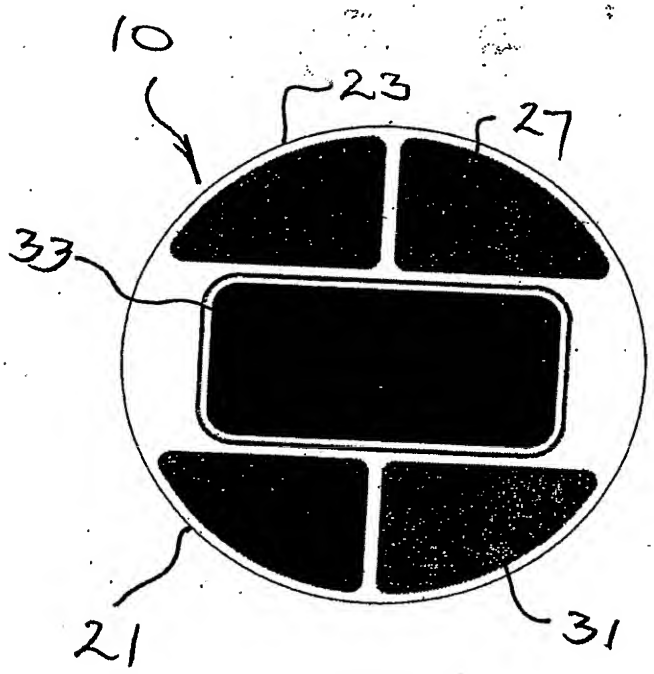
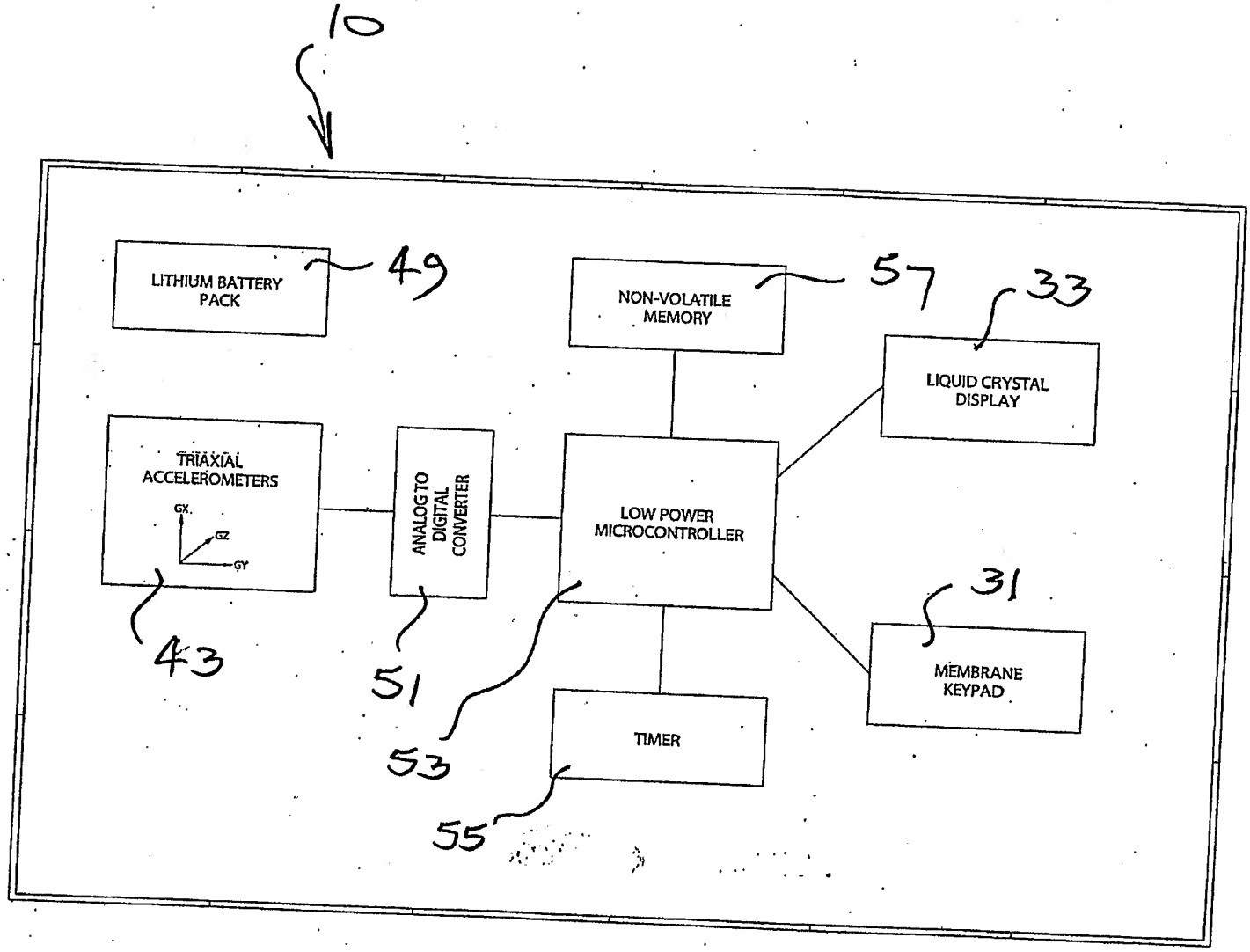


FIG. 5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49
NON-VOLATILE MEMORY
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33
LIQUID CRYSTAL DISPLAY
TRIAXIAL ACCELEROMETERS
GX
GZ
GY
ANALOG TO DIGITAL CONVERTER
LOW POWER MICROCONTROLLER
31
MEMBRANE KEYPAD
TIMER
43
51
53
55

FIG. 6